The National Park Service Vital Signs Monitoring Program

Developing a Systems-Based Monitoring Program as a Key Component of Natural Resource Stewardship

Steven G. Fancy, National Monitoring Leader
NPS Inventory and Monitoring Program

NPS Natural Resource Challenge
Science for Parks - Parks for Science

- Provide funding and new positions for natural resource stewardship to add to NPS visitor services capability
- Learn what is in parks (inventories), and monitor the vital signs of natural systems
- Engage the scientific community and the public, and facilitate their inquiries
- Share the information widely

The Law:

NATIONAL PARKS OMNIBUS MANAGEMENT ACT OF 1998

"The Secretary shall undertake a program of inventory and monitoring of National Park System resources to establish baseline information and to provide information on the long-term trends in the condition of National Park System resources. The monitoring program shall be developed in cooperation with other Federal monitoring and information collection efforts to ensure a cost-effective approach."

"The Secretary shall … assure the full and proper utilization of the results of scientific studies for park management decisions.

Message from Congress:

"This involves a serious commitment from the leadership of the National Park Service to insist that the superintendents carry out a systematic, consistent, professional inventory and monitoring program, along with other scientific activities, that is regularly updated to ensure that the Service makes sound resource decisions based on sound scientific data".

(FY2000 Appropriations Language)

NPS Advisory Board Report:

"A sophisticated knowledge of resources and their condition is essential. The Service must gain this knowledge through extensive collaboration with other agencies and academia, and its findings must be communicated to the public. For it is the broader public that will decide the fate of these resources."

Source: Rethinking the National Parks for the 21st Century. A Report of the National Park System Advisory Board, July 2001

The National Park Service
Inventory & Monitoring

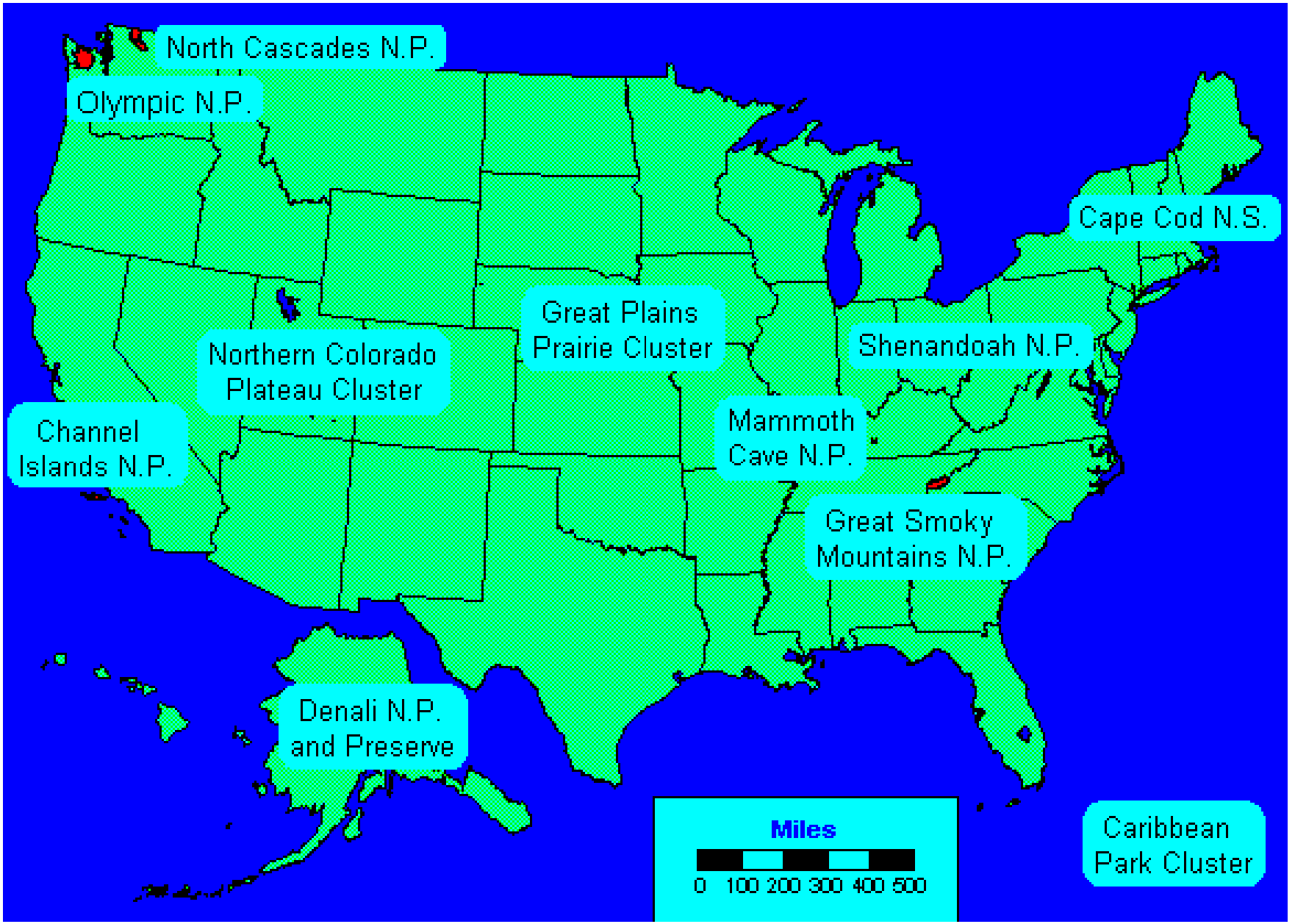
Provide funding and technical support to parks with significant natural resources

LONG-TERM GOAL: Implement ecological monitoring in all units of the NPS.

SHORT-TERM GOALS (as of 1992):

1. Complete baseline resource inventories.
2. Learn how to design and conduct monitoring programs.

Unifying program within the NPS bringing parks and programs together.


North Cascades N.P.
Olympic N.P.
Cape Cod N.S.
Great Plains
Prairie Cluster
Shenandoah N.P.
Northern Colorado
Plateau Cluster
Channel
Islands N.P.
Mammoth
Cave N.P.
Great Smoky
Mountains N.P.
Denali N.P.
and Preserve
Miles
0 100 200 300 400 500
Caribbean
Park Cluster

Role of Prototype Monitoring Programs within National Framework

- **Centers of Excellence**
  - level of monitoring is both more comprehensive and more intensive than in other parks
  - responsible for assisting in the design, development, and testing of monitoring protocols and methods and for providing instruction in their use
- **Mentoring/Technical Assistance**
  - Prototypes possess a wealth of experience and expertise related to the development and implementation of ecological monitoring that can greatly benefit other parks
  - Prototype staff advise and provide technical assistance to other parks on a wide variety of technical issues including conceptual design, database management, data integration and analysis, and reporting of monitoring findings.

Monitoring

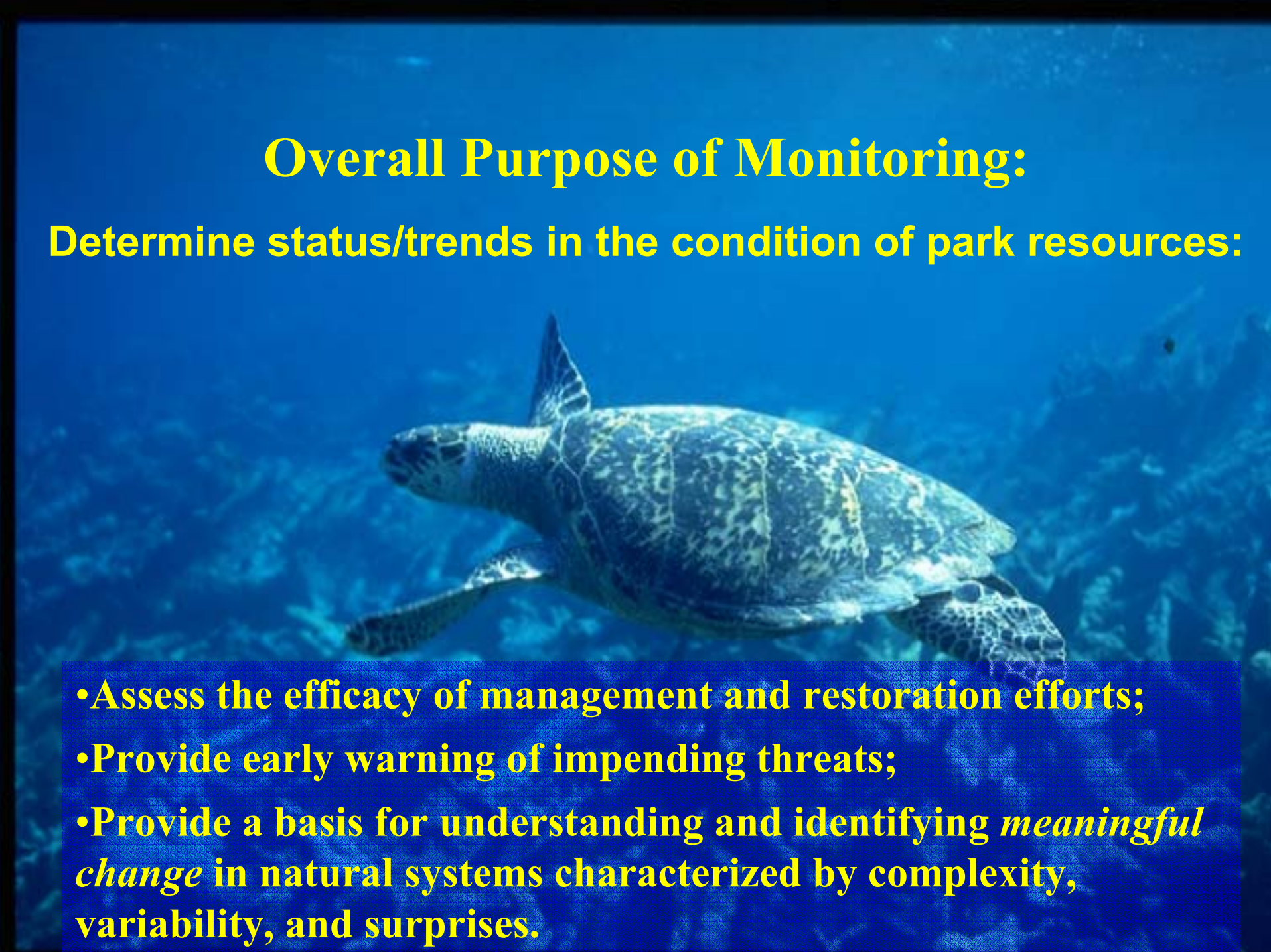
"The collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting management goals".

Key Points:

- **Measurements are repeated to determine change or trend;**
- **Monitoring is done for a specific purpose;**
- **Results will effect an action of some kind, even if the action is to maintain the current management.**

Overall Purpose of Monitoring:

Determine status/trends in the condition of park resources:



- **Assess the efficacy of management and restoration efforts;**
- **Provide early warning of impending threats;**
- **Provide a basis for understanding and identifying *meaningful change* in natural systems characterized by complexity, variability, and surprises.**

National parks are part of larger ecosystems and must be managed in that context.

- most parks are open systems, with threats such as air and water pollution, or invasive species, originating outside of the park's boundaries.
- the appropriate scale for understanding and effectively managing a resource might be at the population, species, community, or landscape level, and in some cases may require a regional, national or international effort to understand and manage the resource.
- protecting and managing a park's natural resources requires a multi-agency, ecosystem approach

Economics 101

$26.5 Million divided evenly among 270 parks

= approx. $100,000 /park

= 1 professional level position + $30-40 K operating $$

Water Quality funds: $2.9 Million = approx. $10K / park

Conclusions:

Without additional funding, parks can only monitor a few vital signs to address issues of highest concern;

Leveraging of funds and Partnerships are very important;

Efficient use of existing personnel and funds from park base and other sources are needed to build an integrated monitoring program that provides the information needed by park managers and for tracking performance towards NR goals.

Natural Resource Challenge

- Accelerate **Inventories**
- Extend **Monitoring**
- **Collaboration** with scientists and others
- Improve **Resource Planning**
- Enhance **Parks for Science**
- Assure **Fully Professional Staff**
- Control **Non-native Species**
- Protect **Native and Endangered Species**
- Enhance **Environmental Stewardship**
- Expand **Air Quality** efforts
- Measure, restore, & protect **Water Resources**
- Use **Parks for Learning**

The Network Strategy

- Strategic approach to allow all parks to identify most critical data needs and begin monitoring planning/design work now; minimum infrastructure
- Group of parks share consistent funding and professional staff to plan/design/implement integrated monitoring.
- Networks augment work already being done by park staff.
- Provide core professional staff that parks can build on.
- Start with modest program, but be optimistic! Build a strong foundation. Demonstrate the value of scientific data for park stewardship, and the funding & staffing will grow.


Olympic NP
North Cascades NP
Prairie Cluster
North Coast and Cascades
Rocky Mountain
Northern Semi-Arid
Klamath
Greater Yellowstone
Northern Great Plains
Great Lakes
Northeast Temperate
Cape Cod NS
Eastern Rivers and Mountains
Northeast Coastal and Barrier
San Francisco Bay
Sierra
Northern Colorado Plateau
Heartland
Mammoth Cave NP
National Capital
Mojave Desert
Northern Colorado Plateau Cluster
Shenandoah NP
Channel Islands NP
Southern Colorado Plateau
Cumberland/ Piedmont
Mid-Atlantic
Mediterranean Coast
Southern Plains
Appalachian Highlands
Sonoran Desert
Southeast Coast
Great Smoky Mountains NP
Chihuahuan Desert
Gulf Coast
Denali NPP
Northwest Alaska
Central Alaska
South Florida/Caribbean
Southwest Alaska
Pacific Islands
South Florida / Caribbean Cluster

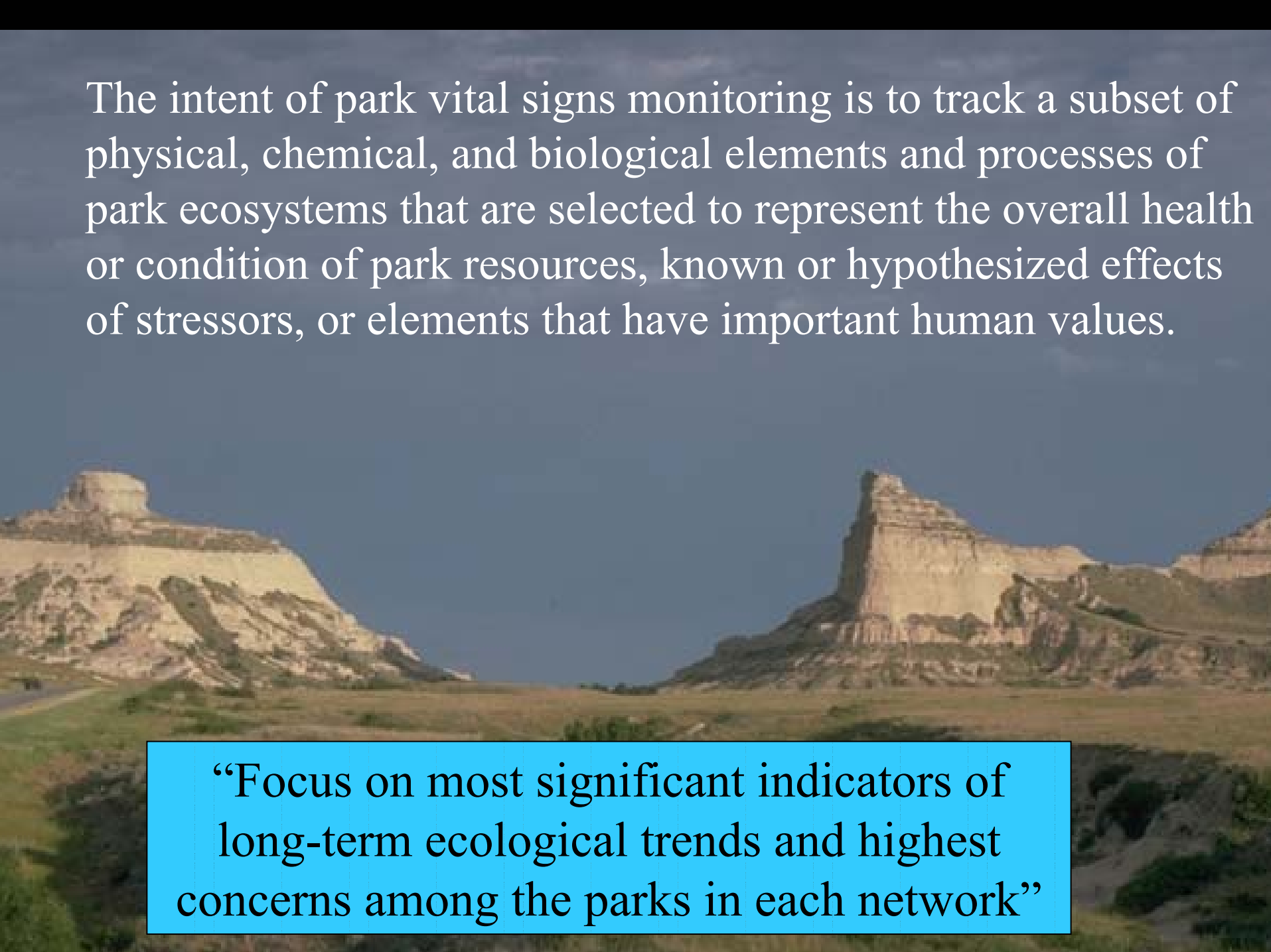
Monitoring Funding Sequence

- 5 "Year 1" networks **(55 parks)**
  - North Coast and Cascades
  - Northeast Coastal and Barrier
  - Heartland
  - Sonoran Desert
  - Cumberland/Piedmont
- 7 "Year 2" networks **(46 parks)**
  - Central Alaska
  - National Capital Region
  - Northern Colorado Plateau
  - Mediterranean Coast
  - Greater Yellowstone
  - Appalachian Highlands
  - San Francisco Bay Area
- 5 "Year 3" networks **(52 parks)**
  - Southwest Alaska
  - Northeast Temperate
  - Southern Colorado Plateau
  - Pacific Island
  - Great Lakes
- 8 "Year 4" networks **(62 parks)**
  - Gulf Coast
  - Rocky Mountain
  - Sierra Nevada
  - Eastern Rivers and Mountains
  - Arctic
  - Klamath
  - Southeast Coast
  - Northern Semi-Arid
- Remaining 7 networks in FY 2005?

Key Features of New Park/Network Monitoring Program

(moving away from the stovepipe model)

- Integrated monitoring program: physical and biological resources including weather, air, water, geoindicators, T&E species, exotic plants, other flora & fauna
- Integrate NR information with other park operations including interpretation, maintenance, law enforcement
- Emphasis on making information more useable; tools such as GIS Theme Manager, NR Database template, NPSpecies, Dataset Catalog, NatureBib Bibliography, interconnected web and distributed databases



The intent of park vital signs monitoring is to track a subset of physical, chemical, and biological elements and processes of park ecosystems that are selected to represent the overall health or condition of park resources, known or hypothesized effects of stressors, or elements that have important human values.

"Focus on most significant indicators of long-term ecological trends and highest concerns among the parks in each network"

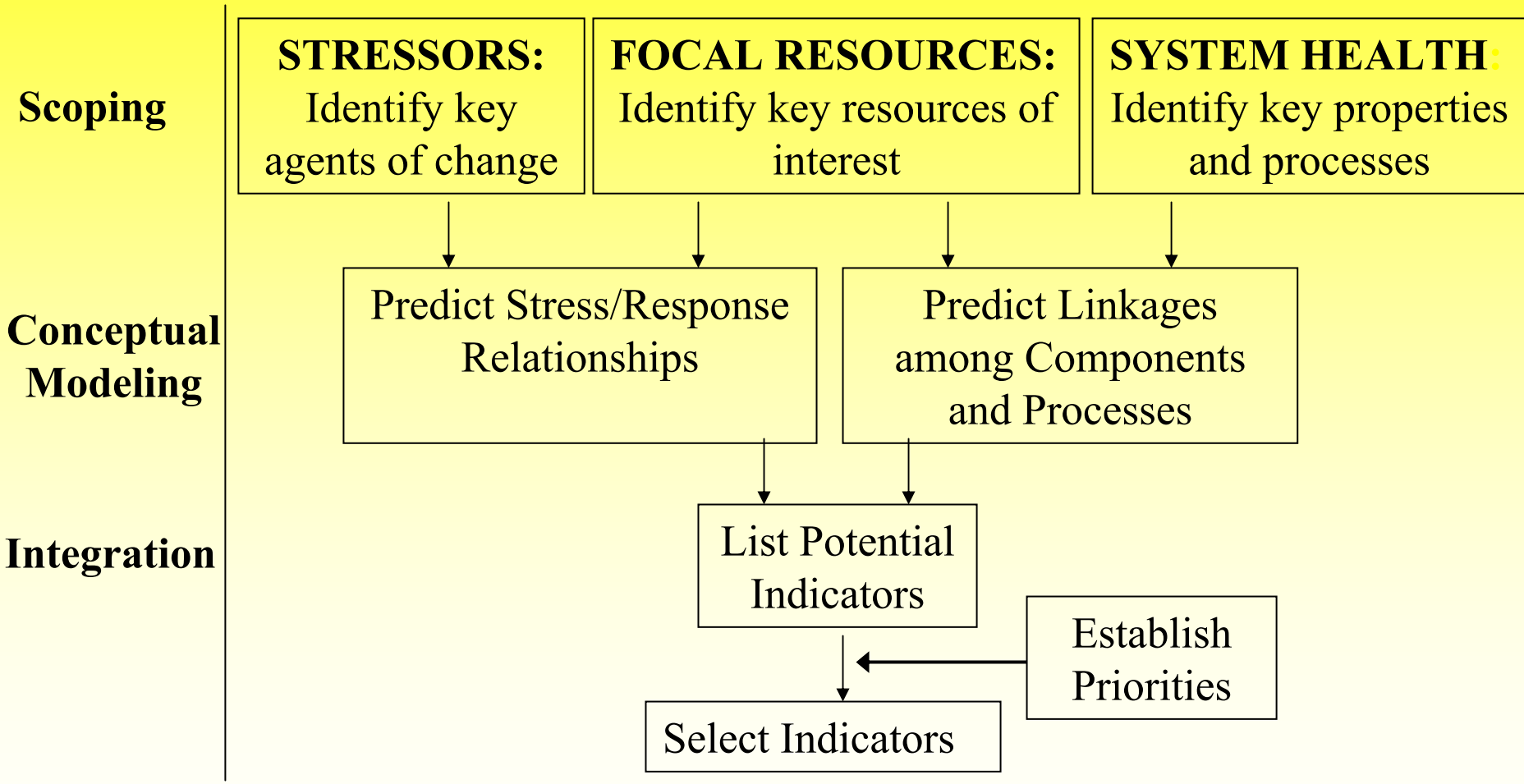
Initial funding will not allow comprehensive monitoring in all parks. Systems-based monitoring of physical and biological resources including the ecological processes that created and continue to act on the park.

Goals of Vital Signs Monitoring

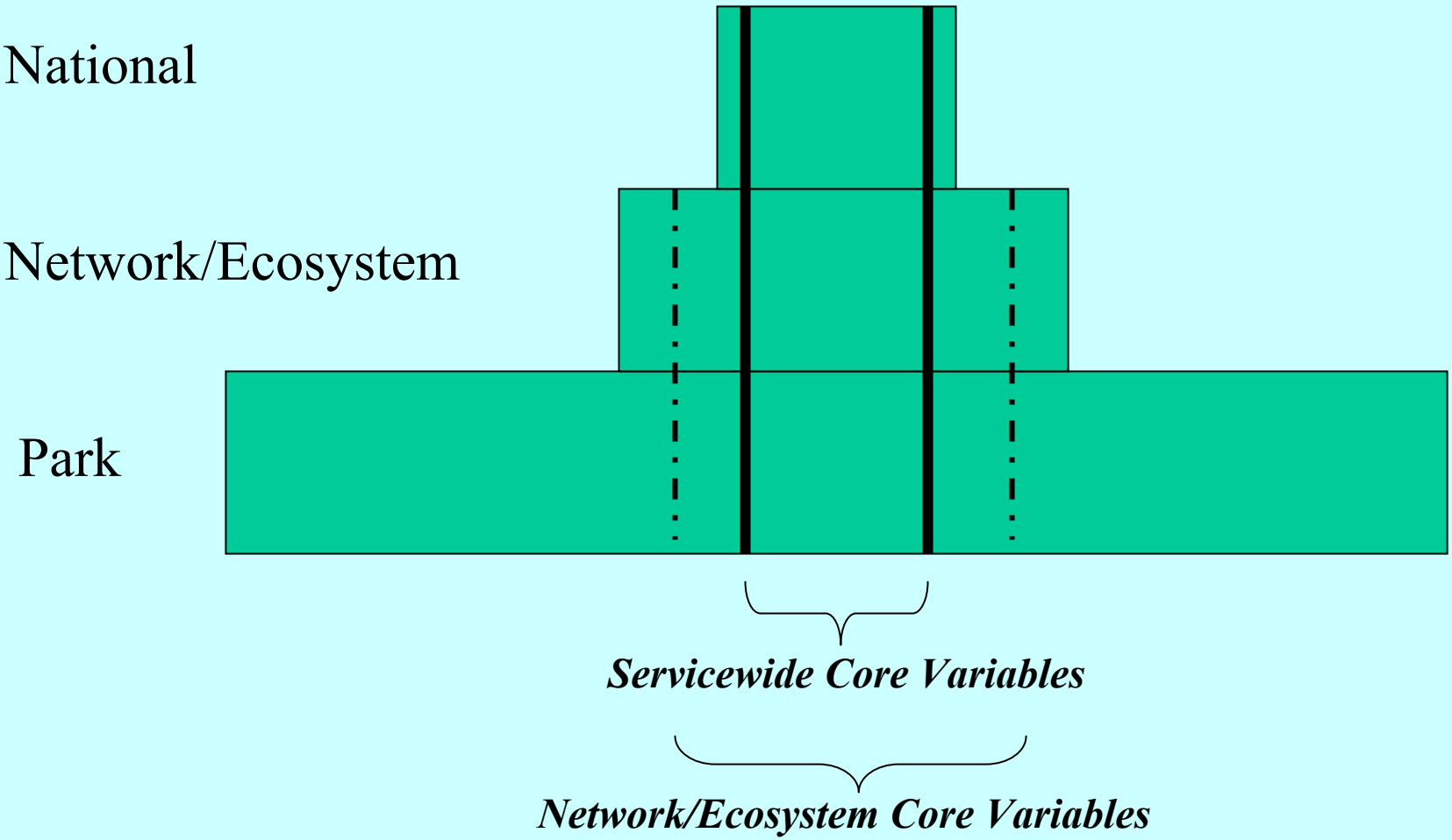
- **Determine status and trends in selected indicators of the condition of park ecosystems to allow managers to make better-informed decisions and to work more effectively with other agencies and individuals for the benefit of park resources.**
- **Provide early warning of abnormal conditions of selected resources to help develop effective mitigation measures and reduce costs of management.**
- **Provide data to better understand the dynamic nature and condition of park ecosystems and to provide reference points for comparisons with other, altered environments.**
- **Provide data to meet certain legal and Congressional mandates related to natural resource protection and visitor enjoyment.**
- **Provide a means of measuring progress towards performance goals.**

Current Approach

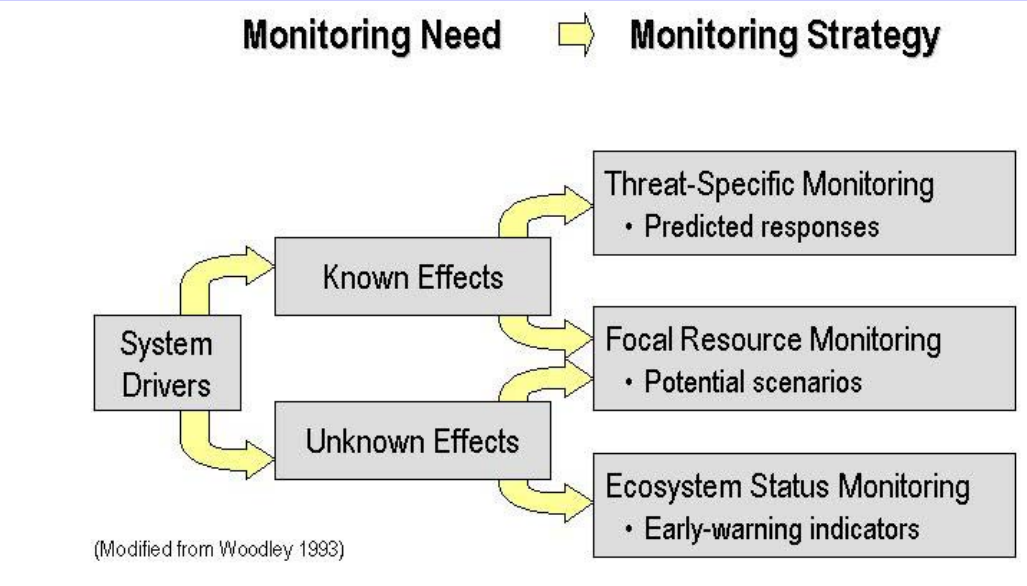
1. Parks and network identify their most critical data needs, and determine partnership opportunities (maximize the use and relevance of data; get the most for your monitoring dollar).
2. Once that is done, identify common ground and additional opportunities for collaboration and consistency among approaches and protocols.
3. Promote sharing/comparing of protocols and datasets via data management and protocol clearinghouse.
4. At the national level, use qualitative measures and in a few cases, standardized quantitative measures, to report on the condition of natural resources and important highlights and trends Servicewide.



Source: Kurt Jenkins, USGS/BRD Olympic Field Station


National
Network/Ecosystem
Park
Servicewide Core Variables
Network/Ecosystem Core Variables

Determining What to Monitor: One Approach



- Ecosystem drivers that fundamentally affect park resources
- Stressors and their ecological effects
- Focal resources of parks
- Key properties and processes of system integrity

What to Monitor?

1. Determine most critical data needs for the park
2. Answer the question, who is interested in the information, and

Clearly defining and agreeing on the Goals and Objectives from the outset is critical to the success of the program!

7-step Approach for Developing a Network Monitoring Program

- Form a Board of Directors and a technical committee to lead/advise the process.
- Summarize existing data and understanding
- Prepare handouts and draft conceptual models for scoping workshop, “Straw man” (1st 3 bullets comprise Phase 1 report)
- Hold a scoping workshop for additional input and peer review.
- Workshop report is written and widely reviewed.
- Board of Directors makes decisions on priorities and implementation.
- Draft monitoring plan is prepared, reviewed and approved

3-Phase Monitoring Design

- Phase 1: Background work prior to selecting vital signs (2 years)
  - goals and objectives for monitoring
  - identify, evaluate, synthesize existing data and understanding (identify and catalog existing data sets)
  - draft conceptual models

- Phase 2: Initial prioritization and selection of vital signs (1 year)
  - update and expand upon Phase I work; select vital signs
  - Phase 2 report satisfies GPRA Goal 1b3, Vital Signs

- Phase 3: Development of full monitoring plan (1-1/2 years +)
  - Detailed design work; protocols, spatial sampling design
  - Design database
  - Write Data Management Plan

Conceptual Models

A conceptual model is a visual or narrative summary that describes the important components of the ecosystem and the interactions among them.

- Conceptual models help us formalize our current understanding of natural processes and anthropogenic stressors affecting ecological integrity.
- They help us to expand our consideration across traditional discipline boundaries.
- Most importantly, clear, simple models facilitate communication among:
  - scientists from different disciplines;
  - researchers and managers;
  - managers and the public.

Prairie Cluster LTEM Program

Anthropogenic Disturbances

Processes

Resources

Indicators

Adjacent Landuse

Fragmentation

Exotic invasion, loss of adjacent habitat, dispersion corridors, water pollution, deer overabundance, fire suppression

Park Resource Management

Prescribed fire, woody plant control, exotic, control, restoration T&E management

Natural Disturbances

Drought, climate cycles, insects, pathogens, fire, grazing

Prairie-woodland ecosystem

prairie plant communities

woodland plant communities

unique habitats

streams

grassland bird communities

prairie dogs

T&E plants

Changes in adjacent landuse

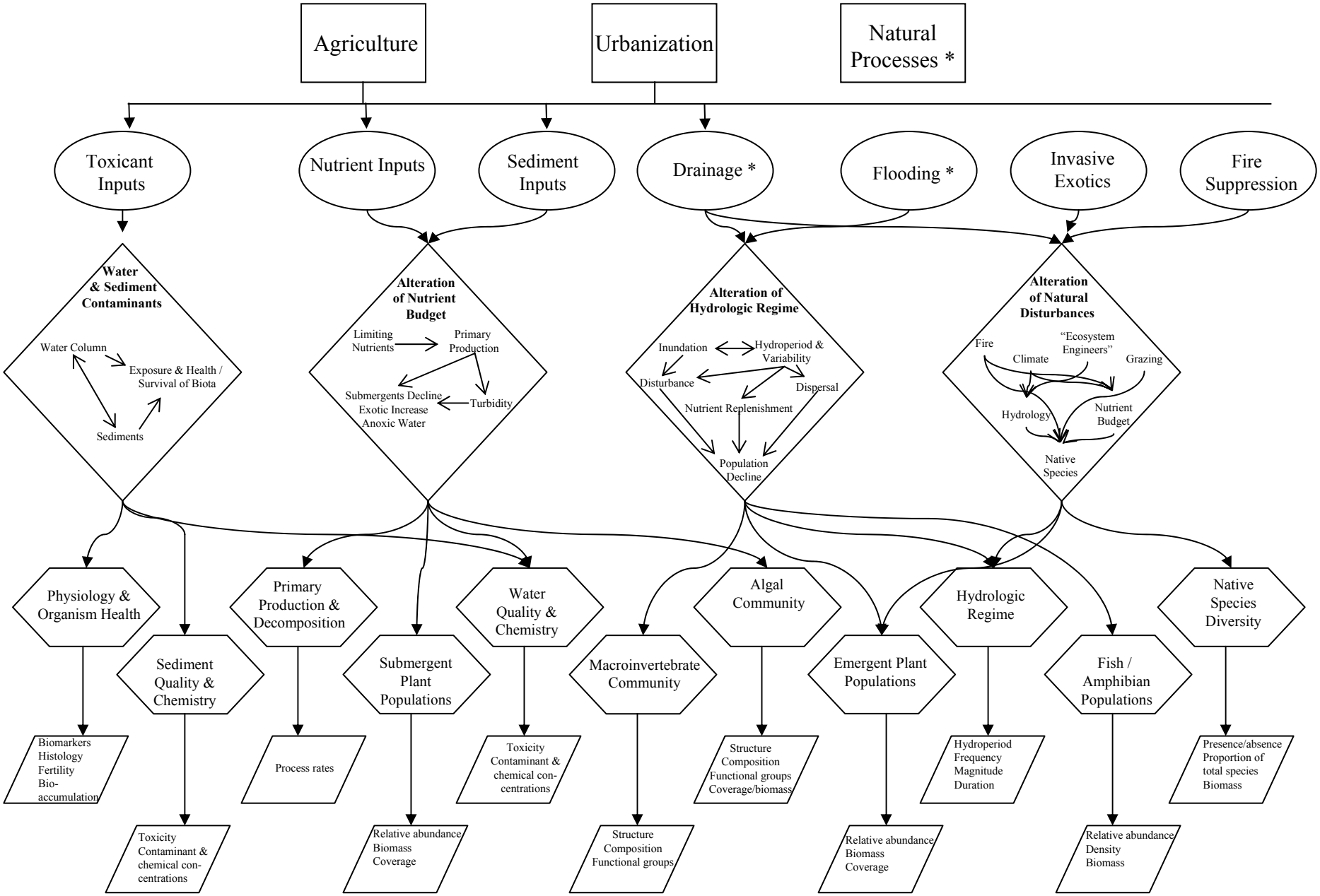
Butterflies as indicators of ecosystem health

Plant community composition, structure

Macroinvertebrates indicators of stream health

Diversity, species composition

Population size, area of habitat


Agriculture
Urbanization
Natural Processes *
Toxicant Inputs
Nutrient Inputs
Sediment Inputs
Drainage *
Flooding *
Invasive Exotics
Fire Suppression
Water & Sediment Contaminants
Water Column
Exposure & Health / Survival of Biota
Sediments
Alteration of Nutrient Budget
Limiting Nutrients
Primary Production
Submergents Decline
Exotic Increase
Anoxic Water
Turbidity
Alteration of Hydrologic Regime
Inundation
Hydroperiod & Variability
Disturbance
Dispersal
Nutrient Replenishment
Population Decline
Alteration of Natural Disturbances
Fire
"Ecosystem Engineers"
Climate
Grazing
Hydrology
Nutrient Budget
Native Species
Physiology & Organism Health
Sediment Quality & Chemistry
Primary Production & Decomposition
Submergent Plant Populations
Water Quality & Chemistry
Macroinvertebrate Community
Algal Community
Emergent Plant Populations
Hydrologic Regime
Fish / Amphibian Populations
Native Species Diversity
Biomarkers
Histology
Fertility
Bio-accumulation
Toxicity
Contaminant & chemical con-centrations
Process rates
Relative abundance
Biomass
Coverage
Toxicity
Contaminant & chemical con-centrations
Structure
Composition
Functional groups
Structure
Composition
Functional groups
Coverage/biomass
Relative abundance
Biomass
Coverage
Hydroperiod
Frequency
Magnitude
Duration
Relative abundance
Density
Biomass
Presence/absence
Proportion of total species
Biomass

Tasks that Need to Be Completed Before Monitoring Field Work Begins:

- Clearly define **Goals and Objectives**
- Develop **Monitoring Protocols**
- Design **Field Data Forms**
- Design **Database**
- Write **Data Management Plan**
- Determine **Data Analysis Procedures**
- Determine **Content, Audiences for Reports**

NPS Natural Resource Challenge

The NPS, for the first time, is developing a data management capability at the park, regional and national levels that will allow parks to make better use of existing data as well as making new data available to managers, researchers, the public and others.

= Institutional Knowledge

Integration of data sets

Monitoring Program Viewpoint/Rules

- Good data management planning and practices are vital to institutional knowledge and carrying out our stewardship mission.
- 30% rule of thumb: adequate time and resources must be available for data management and reporting.
- New funding cannot be used to support field data collection until protocols and database are in place.

Outline for a Network Vital Signs Monitoring Plan

Note: Chapter headings are fixed, but networks are free to organize material within each chapter as appropriate to make the plan more easily understood and organized.

Executive Summary

Chapter 1	**Introduction and Background**
Chapter 2	**Conceptual Models**
Chapter 3	**Prioritization and Selection of Vital Signs**
Chapter 4	**Sampling Design**
Chapter 5	**Sampling Protocols**
Chapter 6	**Data Management**
Chapter 7	**Data Analysis and Reporting**
Chapter 8	**Admin./Implementation of Monitoring Program**
Chapter 9	**Schedule**
Chapter 10	**Budget**
Chapter 11	**Literature Cited**

Glossary

Appendices

Phase 1 = Draft Chapters 1 and 2
Phase 2 = Updated Chapters 1 and 2, plus Chapter 3

Web-based Clearinghouse of Protocols and Database Components

Amphibian Call Counts	Protocol	Database*	Data Analysis
Bird VCP counts	Protocol	Database	Data Analysis
Breeding Bird Survey	Protocol	Database	Data Analysis
Coral reef video sampling	Protocol	Database	Data Analysis
Rare plants	Protocol	Database	Data Analysis
Rare plants	Protocol	Database	Data Analysis
Weather	Protocol	Database	Data Analysis
Weather	Protocol	Database	Data Analysis
Weather	Protocol	Database	Data Analysis

* Database is an MS Access .mdb file with tables, queries, forms, reports designed for a particular protocol.

The National Park Service
Inventory and Monitoring

PROTOCOL DATABASE

PROTOCOL NAME	PARK	STATUS	SUMMARY	PROTOCOL	MS ACCESS	ANALYSIS
Air Quality	DENA	Completed	Summary			
Amphibians	CACO	R&D Phase	Summary			
Amphibians	NOCA	R&D Phase	Summary			
Bald Eagles	NOCA	Completed	Summary			
Bats	ORPI	Completed	Summary	Protocol		
Black Bear	GRSM	Completed	Summary			
Black-tailed Prairie Dog	PRCL	Completed	Summary	Protocol		
Coral Colonies	VIIS	R&D Phase	Summary			
Coral Reefs	VIIS	Completed	Summary			
Data Management	DENA	R&D Phase	Summary			
Down Woody Debris and Fuels - FIA	MANY	Completed	Summary	Protocol		

The National Park Service

Inventory & Monitoring

Black-tailed Prairie Dog

REFERENCE

Plumb, G.E., G.D. Willson, K. Kalin, K. Shinn, and W.M. Rizzo. 2001. Black-tailed prairie dog monitoring protocol for seven prairie parks. U.S. Geological Survey, Northern Prairie Wildlife Research Center, Missouri Field Station, Columbia, MO. 27 p.

DESCRIPTION

Protocol designed to (1) provide relatively simple and cost-effective procedure for estimating density and total size of black-tailed prairie dog colonies, (2) delineate and map edges of colonies, (3) provide low-level surveillance of sylvatic plague. The maximum numbers of individuals that are observed during three consecutive mornings of colony surveillance each year are used to calculate population sizes and densities. Extent of both the clip line and active burrow line are mapped annually using GPS.

USGS
science for a changing world

Black-tailed Prairie Dog Monitoring Protocol for Seven Prairie Parks

Northern Prairie Wildlife Research Center Inventory and Monitoring Protocol

Black-tailed Prairie Dog Monitoring Protocol for Seven Prairie Parks

by

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Data Management Considerations …

- Much of the data analysis, synthesis, modeling, and learning from data collected by NPS staff and cooperators will be done by researchers, grad students, post-docs etc. outside of the NPS; data sets must be documented and structured to allow analysis by others.
- For many analyses, need to merge data from different sources (e.g., download weather or air quality data from website, satellite or aerial images, veg maps, plant & animal data).
- You will never get everyone to use the same software or data structure, and you don't need to, to allow sharing, comparing, synthesis of data. What is important is the ability to export data from different data sources to a common format for analysis.
- Within the NPS, if you want to be able to borrow and learn from others and work together, you need to work within some sideboards. If everybody does their own thing …
- Remember that we are building the foundation for a long-term program.

Reporting the Results of I&M Efforts

Making Data, Information Available for Decision-Makers, Scientists, Educators, and various Constituency Groups

- Annual Administrative Report and Work Plan
- Annual Reports for specific Protocols or Projects
- Inventory Project Reports
- Analysis and Synthesis reports – trends
- Program and Protocol Review reports
- Scientific journal articles and book chapters
- Symposia, workshops and conferences
- National Report - Condition of NR in National Parks
- Websites

I&M Home
Inventories
Monitoring
National Framework
Program Development
QA/QC
Data Management
Literature/Other Links
I&M GIS Program
Data Management
Parks and Networks
Applications and Databases
Reports
Standards and Policies
Related Links
I&M Intranet

NatureBib
NPSpecies
NR/GIS Metadata
NR FTP Site
Desktop Database Applications
GIS Applications
NPS FTP Site

I&M Program Search
Search I&M go
NPS I&M All NPS

Monitoring Natural Resources in Our National Parks

- INTRODUCTION AND BACKGROUND
  - Justification for Integrated Natural Resource Monitoring
  - Legislation and Policy
  - Definition of Key Terms
  - Characteristics of Successful Monitoring Programs
  - National Framework For Inventory and Monitoring
    - National and Regional Oversight
    - Basic Resource Inventories
    - Prototype Monitoring Programs
    - Vital Signs Monitoring Networks
- DEVELOPMENT OF MONITORING PROGRAMS
  - Introduction
  - Establishing Monitoring Goals and Objectives
  - Developing Conceptual Models of Relevant Ecosystem Components
  - Prioritizing and Selecting Indicators - What Should be Monitored?
  - Sampling Design Considerations - Where and When to Sample
  - Protocols Used in National Parks and by Other Agencies
    - **Protocol Database**
  - Integration: Ecological, Spatial, Temporal and Programmatic
  - **Handbook for Vital Signs Monitoring**
  - Downloadable Documents Relevant to Monitoring Design
- QUALITY ASSURANCE/QUALITY CONTROL
- DATA MANAGEMENT AND REPORTING
  - Information Management Tools
  - Annual Reports
  - Metadata
- LITERATURE CITED
- OTHER LINKS AND DOCUMENTS
- Monitoring Intranet

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Inventory and Monitoring Program http://www1.nrintra.nps.gov/im/monito

Program Activities

- Biological Inventories
- Vital Signs Monitoring
- I & M Networks
- Data Management Guidance and Documents
- Natural Resource GIS
- Program Reports

NPS Vital Signs Monitoring Intranet

Memos and Other Guidance Documents

The following memos and documents establish the official guidance for the vital signs monitoring program:

Download October 13, 2000 Memo Memo to Regional Directors from Assoc. Director Soukup, dated October 13, 200
Program: Vision and Implementation plan. Presents the Servicewide Vision and Implementation Plan for the vital signs
recommended 7-step process for planning and designing a network monitoring program.

Download December 21, 2000 Memo Memo to Regional Directors from Assoc. Director Soukup, dated December 21
Prototype and Core Park Vital Signs Monitoring. Describes funding for prototype monitoring parks and for network vital
monitoring funds for high-priority inventories in the event that all planning and design work for monitoring is being comp

Download Integrated Monitoring Memo Memo to Regional Directors from Assoc. Director Soukup, dated December 2
Monitoring Implementation and Integration of Water Quality Monitoring and (future) Air Quality Components. Describes
the Water Quality monitoring and Air Quality monitoring components of the Natural Resource Challenge with the core

Download March 9, 2001 Memo Memo to Regional Directors from Assoc. Director Soukup, dated March 9, 2001, Su
Vital Signs Monitoring. Describes accountability measures (network charters, annual work plans) and funding for FY 2

Download Annual Admin. Report and Work Plan Memo Memo to Regional Directors from Assoc. Director Soukup, d
Administrative Report and Work Plan for Inventories and Park Vital Signs Monitoring. Provides guidance and an examp
Plan that each network and prototype park must provide to WASO by the end of October 2001.

Download I&M Overhead Policy Memo Memo to Regional Directors dated November 30, 2001, Subject: Policies Con
Monitoring Funding. Provides policy and guidance on use of Natural Resource Challenge funding from Inventory and M
assistance.

Download January 3, 2002 Memo Memo to Regional Directors from Assoc. Director Soukup, dated January 3, 2002,
Park Vital Signs Monitoring. Describes funding in FY02 for prototype parks and networks, as well as additional comm

Download February 21, 2002 Memo Memo to Regional Directors dated February 21, 2002, Subject: Administration o
Funding and Positions: New Organization Codes. Establishes the new budget organization codes for the 32 networks

Things to Keep in Mind

- We are starting with a core program with shared personnel and funding - plan for future growth
- Use funding for leveraging, cost sharing; augment with existing park staff, park base, partnerships
- Demonstrate that data are useful for managing park resources and meeting the NPS mission
- Partnerships are key to designing and building an integrated program
- If more people use the data, there will be more support for the program. Share the results widely! Multiple products for multiple audiences.

Natural Resource Challenge
Inventory & Monitoring

Revitalize and expand the natural resource program within the park service and improve park management through greater reliance on scientific knowledge

Organ Pipe Cactus N.M. © D. Liggett